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Research Article

The Diagnostic Value of Virtual Colonoscopy in Colonic Diseases

Kolon Hastalıklarında Sanal Kolonoskopinin Tanısal Değeri

Ihsaniye Suer Dogan*[1], Esin Cakmakci[2], Yildiran Songur[3], Baki Hekimoglu[4]

[1]Ministry of Health Etlik City Hospital, Department of Radiology, Ankara, Turkey
[2]Kansas City VA Medical Center Department of Radiology, USA
[3]Nyclinic, Gastroenterology Antalya, Turkey
[4]Dışkapı Yıldırım Beyazıt Mevki Hospital Department of Radiology, Ankara, Turkey

Abstract

Aim: This study aims to assess the diagnostic accuracy of multi-slice computed tomography (CT) colonography in detecting colorectal lesions.

Material and Methods: 22 patients with confirmed or clinically suspected colorectal pathology underwent multi-slice CT colonography followed by conventional colonoscopy on the same day. The diagnostic findings of multi-slice CT colonography were compared with those obtained from conventional colonoscopy.

Results: Of 22 patients who underwent CT colonography, 10 (45%) were evaluated as normal. Bowel wall thickening was observed in 4 patients (18%), while polypoid lesions were detected in 8 (36%). Among the 9 polypoid lesions identified through conventional colonoscopy, 8 were also detected by CT colonography. The overall sensitivity of CT colonography for polypoid lesions, regardless of size, was 89%. Sensitivity was 50% for lesions smaller than 1 cm and 100% for lesions larger than 1 cm. When polypoid lesions were evaluated according to their histology, the sensitivity of CT Colonography was found to be 50% in tubular adenoma, 100% in tubulovillous adenoma, and 100% in adenocarcinoma.

Conclusion: The sensitivity of CT colonography for detecting colorectal polypoid lesions was found to be 89%. These results indicate that CT colonography is a valuable diagnostic modality for comprehensive evaluation of the colon. CT colonography represents a viable alternative to traditional colorectal cancer screening methods due to its high sensitivity for detecting colorectal lesions, coupled with its relatively safe and minimally invasive nature.

Keywords: Computed Tomography Colonography, Colonoscopy, Colonic Polyp, Colorectal Neoplasms

Corresponding Author*: Ihsaniye Suer Dogan, Ministry of Health Etlik City Hospital, Department of Radiology, Ankara, Turkey,
E-mail: dr.ihsaniye@gmail.com
Orcid: 0000 0002 7586 0537
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Öz

Amaç: Çok kesitli bilgisayarlı tomografi (BT) kolonografinin kolorektal lezyonların görülmesindeki ve ek bulguların araştırılmasındaki etkinliğini değerlendirmektir.

Gereç ve Yöntemler: Kolorektal patolojisi olan veya klinik olarak şüphelenilen 22 hastaya aynı gün BT kolonografi sonra konvansiyonel kolonoskopi incelemesi yapıldı. Çok kesitli BT kolonografi, konvansiyonel kolonoskopi sonuçları karşılaştırıldı.

Bulgular: BT kolonografi de 22 hastanın 10 tanesi (%45) normal olarak değerlendirildi. Dört hastada (%18) barsak duvarında kalınlaşma, 8 hastada (%36) polipoid lezyon saptandı. Konvansiyonel kolonoskopi de saptanan 9 polipoid lezyonun 8 tanesi BT kolonografi de saptandı. Boyut farkı gözetmeksizin tüm polipoid lezyonlarda BT kolonografinin duyarlılığı %89, 1 cm'den küçük polipoid lezyonlarda %50, 1 cm'den büyük polipoid lezyonlarda %100 bulundu.

Sonuç: BT kolonografisinin kolorektal polipoid lezyonları tespit etme duyarlılığı %89 olarak bulundu. Bu sonuçlar BT kolonografisinin kolonun kapsamlı değerlendirilmesi için değerli bir tanı yöntemi olduğunu göstermektedir. BT kolonografisi, kolorektal lezyonları tespit etmedeki yüksek duyarlılığı ve nispeten güvenli ve minimal invaziv yapısı nedeniyle geleneksel kolorektal kanser tarama yöntemlerine uygulanabilir bir alternatif sunmaktadır.

Anahtar Kelimeler: Bilgisayarlı Tomografi Kolonografi, Kolonoskopi, Kolon Polip, Kolorektal Neoplazmalar

Introduction

In developed nations, colorectal cancer (CRC) stands as one of the principal causes of cancer-related mortality [1]. The prevalence of CRC is also on the rise in our country. On a global scale, CRC is the third most commonly diagnosed malignancy and the second leading cause of cancer-related deaths.

The precise etiology of CRC remains elusive. Despite the potential for early diagnosis to markedly enhance prognosis, CRC frequently presents without distinct clinical symptoms or only vague, non-specific signs during its early stages, resulting in a low rate of early detection [2]. Given the well-documented progression of colorectal polyps to carcinoma over time, the early identification of premalignant lesions, such as polyps, is critical for improving patient outcomes [3]. Early detection and subsequent removal of these polyps can significantly reduce the likelihood of CRC development.

Colonoscopy remains the gold standard for the detection of CRC; however, it is both financially demanding and resource-intensive, requiring skilled endoscopists and strong patient compliance. Furthermore, it is an invasive procedure, carrying inherent risks such as bowel perforation and bleeding [4,5]. For a comprehensive examination, complete visualization of the entire colon is also essential.

Computed tomography (CT) colonography, by contrast, is a rapid, non-invasive imaging modality for colorectal evaluation. It utilizes computed tomography to detect polyps and malignancies. Standard protocols typically involve bowel preparation, oral contrast administration, and colon insufflation, but do not necessitate sedation [6].

This study aims to assess the diagnostic accuracy of multi-slice CT colonography in detecting colorectal lesions and evaluating additional findings.

Material and Methods

Between December 2002 and July 2003, a total of 22 patients with confirmed or clinically suspected colorectal pathology underwent CT colonography at the Radiology Department of Social Security Institution Dışkapı Ankara Training Hospital. The study was studied prospectively within the Declaration of Helsinki Principles guidelines. This thesis study was conducted with the permission of the Radiology Department of Social Security Institution Dışkapı Ankara Training Hospital (ethical approval date: 18.07.2022 no: 08)

The findings were correlated with conventional colonoscopy and histopathological results. Positive and false-negative cases were identified to evaluate the diagnostic performance of CT colonography in detecting colorectal pathologies.

Patients included in the study were those with positive faecal occult blood tests, rectal bleeding, a history of adenomatous polyps, previous surgical intervention for colorectal carcinoma, or confirmed/suspected inflammatory bowel disease. Patients under the age of 18 were excluded from the study.

Before the examination, patients were instructed to follow a liquid diet for three days. On the day before the procedure, bowel cleansing was achieved using either Fleet Phospho-Soda solution (monobasic sodium phosphate 2.4 g + dibasic sodium phosphate 0.9 g/5 mL) or X-M solution (Sennoside A+B Ca 150 mg). All CT colonography examinations were conducted on the same day as conventional colonoscopy. To reduce smooth muscle spasms

and peristalsis, 2 mL of intravenous hyoscine butylbromide was administered immediately before the procedure. Following the placement of a 16F Foley catheter into the rectum, room air was insufflated manually using a hand pump until adequate colonic distension was achieved, as tolerated by the patient. Air insufflation was halted upon the patient reporting abdominal distension or discomfort. A scout image of the abdomen and pelvis was then obtained with the patient in the supine position.

CT colonography examinations were performed using a multi-slice computed tomography scanner (Marconi MX 8000). Axial images of the abdomen, extending from the dome of the diaphragm to the symphysis pubis, were obtained with a slice thickness of 3.2 mm, a reconstruction interval of 1.6 mm, a pitch of 1.75, and a 512x512 matrix. The scans were completed within 10–15 seconds during a single breath-hold.

Following the initial scan, with the patient in the prone position, 90–100 mL of intravenous contrast material was administered at a rate of 3.5 mL/second using an automatic injector. A delayed scan was performed 70 seconds post-contrast administration. The acquired images were transferred to a secondary workstation (MX View) capable of 3D reconstruction.

Axial 2D images, multiplanar reformatted (MPR) images, and 3D endoluminal views (virtual colonoscopy) were independently evaluated by two radiologists. Final decisions were made by consensus for each patient. Axial CT images were reviewed using a window width of +1000 HU and a window level of -500 HU. In cases of uncertainty, 2D MPR and 3D endoluminal images were utilised for further assessment.

Conventional colonoscopy was performed by an experienced gastroenterologist (YS) using a standard endoscope, without prior knowledge of the CT colonography findings. The procedure documented which segments of the colon were adequately visualised, and any detected lesions were reported based on their location and size.

The findings from conventional colonoscopy and CT colonography were compared on a lesion-by-lesion basis. Conventional colonoscopy was regarded as the gold standard. For a lesion detected by CT colonography to be considered a true positive, its location and size had to match the corresponding findings from conventional colonoscopy.

Statistical Analysis

Descriptive statistics for continuous variables included calculating mean values, standard deviations, medians, and ranges (minimum and maximum). For categorical variables, frequencies and percentages were presented. The McNemar test was employed to assess statistical significance. Data analysis was performed using IBM SPSS for Windows (SPSS Inc., Chicago, IL), with a p-value of <0.05 considered indicative of statistical significance.

Results

The ages of the patients ranged from 22 to 80 years, with a mean age of 56.5 years. Of the 22 patients, 13 were male (59%).

CT colonography identified 10 patients (45%) as having normal findings. Bowel wall thickening was observed in 4 patients (18%), and polypoid lesions were detected in 8 (36%). Among the 10 patients deemed normal on CT colonography, 8 were also assessed as normal by conventional colonoscopy (Figure 1).

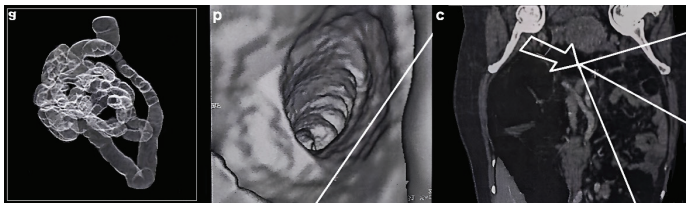

Figure 1. Normal computed tomography colonography (a), virtual endoluminal image (b) and coronal multiplanar reformatted image (c).

Histopathological analysis of lesions identified through conventional colonoscopy revealed the following: inflammatory bowel disease in 6 cases (26%), tubular adenoma in 2 cases (8.7%), tubulovillous adenoma in 1 case (4.3%), and adenocarcinoma in 3 (%13) cases. Of the 9 polypoid lesions examined histopathologically, 1 (11%) was associated with inflammatory bowel disease, 2 (22%) with tubular adenoma, 1 (11%) with tubulovillous adenoma, and 3 (33%) with adenocarcinoma (Table 1).

The overall sensitivity of CT colonography for polypoid lesions, regardless of size, was 89%. Sensitivity was 50% for lesions smaller than 1 cm and 100% for lesions larger than 1 cm (Table 2).

When polypoid lesions were evaluated according to their histology, the sensitivity of CT Colonography was found to be 50% in tubular adenoma, 100% in tubulovillous adenoma, and 100% in adenocarcinoma (Table 3) (Figure 2) (Figure 3).

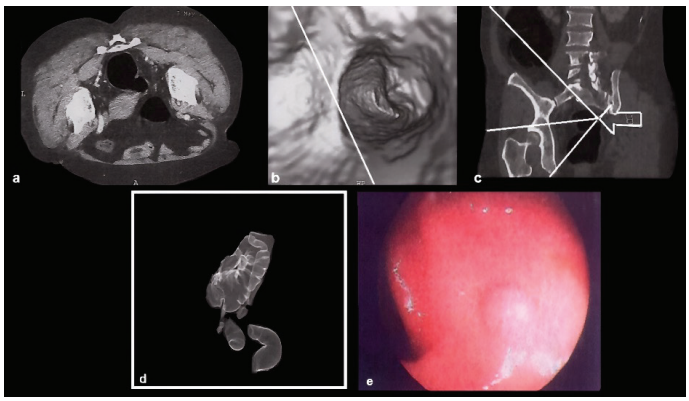

Figure 2. 0.5 mm polyp in rectum, 2D axial section (a), virtual endoluminal image (b) coronal multiplanar reformatted image (c) Polyp in virtual colonoscopy (d) conventional colonoscopy (e).

Table 1. Classification of polypoid masses detected by conventional colonoscopy based on size and histology.					
Size	Tubular Adenoma	Tubulovillous Adenoma	Adenocarcinoma	Inflammatory Bowel Disease	Total
Less than 1 cm (<1cm)	2 (22%)				2
Equal and greater than 1 cm (≥1cm)		1 (11%)	3 (33%)	1 (11%)	5
Total	2 (22%)	1 (11%)	3 (33%)	1 (11%)	7

Table 2. Sensitivity of computed tomography colonography in detecting polypoid lesions based on size.				
Category	Total	True Positive	False Negative	Sensitivity
All polypoid lesions	9	8	1	89%
Less than 1 cm (<1cm)	2	1	1	50%
Equal and greater than 1 cm (≥1cm)	7	7	0	100%

Table 3. Sensitivity of computed tomography colonography in detecting polypoid lesions based on histology.				
Histology	Total	True Positive	False Negative	Sensitivity
Tubular Adenoma	2	1	1	50%
Tubulovillous Adenoma	1	1	0	100%
Adenocarcinoma	3	3	0	100%

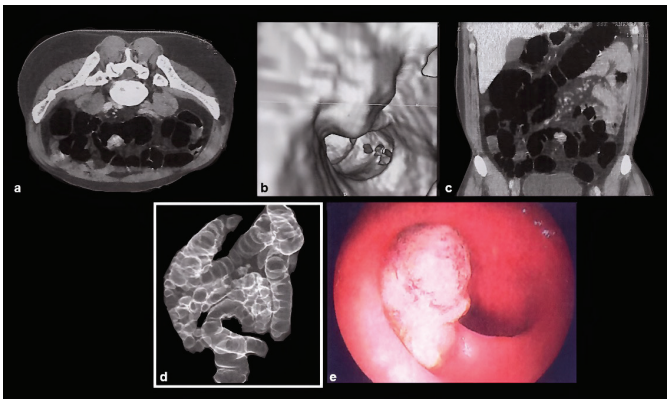

Figure 3. 3 cm polyp in sigmoid colon , 2D axial section (a), virtual endoluminal image (b), coronal multiplanar reformatted image (c), Polyp in virtual colonoscopy (d) and conventional colonoscopy (e).

Discussion

CRC is a significant public health issue, leading to substantial morbidity and mortality. Common diagnostic methods for colorectal cancer include the faecal occult blood test, flexible sigmoidoscopy, double-contrast barium enema, and colonoscopy.

Colonoscopy is considered the gold standard for colorectal evaluation as it provides direct visualisation of the mucosa and serves both diagnostic and therapeutic purposes. While numerous techniques are available for imaging the colon, each has its limitations. A critical aspect of colorectal examination is achieving complete visualisation of the entire colon.

CT colonography has emerged as the most effective radiological procedure for diagnosing colorectal neoplasms and is the leading non-invasive modality for this purpose. Consequently, it is recommended as the preferred radiological examination for the clinical evaluation of colorectal neoplasms [7]. CT colonography exposes patients to minimal radiation while eliminating the risks associated with intubation and sedation. It is particularly suitable for patients who are unable or unwilling to undergo traditional colonoscopy or sedation [8].

In one of the earliest studies on CT colonography, Hara et al. evaluated 30 endoscopically confirmed polyps. They reported a sensitivity of 100% for polyps larger than 1 cm, 71% for polyps measuring 0.5–0.9 cm, and 28% for polyps smaller than 0.5 cm [9]. In a separate study involving 70 patients, the sensitivity of CT colonography was found to be 75% for lesions larger than 1 cm, 66% for adenomatous polyps measuring 5–10 mm, and 45% for polyps smaller than 5 mm [10]. Fletcher et al., in their study of 180 patients, reported a patient-based sensitivity of 85% and specificity of 93% for polyps 1 cm or larger, with a polyp-based sensitivity of 75% [11]. In another study conducted by Hara et al. involving 237 high-risk patients, the patient-based sensitivity was 100%, specificity was 90%, and polyp-based sensitivity for polyps 1 cm or larger was 89% [12]. Yee et al., in a study with 300 patients, found a patient-based sensitivity of 100% and a polyp-based sensitivity of 93% for polyps 1 cm or larger [13]. Additionally, Mulhall et al. conducted a meta-analysis involving 6,393 patients across 33 trials, further reinforcing the diagnostic utility of CT colonography. The sensitivity of CT colonography varies depending on polyp size, with higher sensitivity observed

for larger polyps. For polyps smaller than 6 mm, sensitivity was reported at 48% (95% CI: 25%–70%), increasing to 70% (95% CI: 55%–84%) for polyps measuring 6–9 mm, and 85% (95% CI: 79%–91%) for polyps larger than 9 mm [14]. In a study by Sato et al., CT colonography accurately identified 86 out of 87 central colon tumours. By utilising CT colonography and excising one minor lesion, they successfully detected all 87 tumours. The authors suggest that clipping could be further explored as a technique for diagnosing small tumours, particularly those less than 10 mm in diameter [15]. Weinberg et al. found that CT colonography demonstrated a sensitivity of 44.0% (95% CI: 30.2%–57.8%) and a specificity of 93.4% (95% CI: 89.7%–97.0%) for polyps smaller than 6 mm. For polyps smaller than 10 mm, the sensitivity was 76.9% (95% CI: 54.0%–99.8%) and the specificity was 89.0% (95% CI: 84.8%–93.1%) [16]. In a study conducted by Royster et al. involving 20 patients with suspected colorectal cancer, all lesions measuring 2 cm or larger were successfully detected, yielding a sensitivity of 100% [17]. In our study, 8 out of 9 polypoid lesions identified through conventional colonoscopy were also detected by CT colonography. The overall sensitivity of CT colonography for detecting polypoid lesions, irrespective of size, was determined to be 89%.

In our study, CT colonography demonstrated a sensitivity of 100% for detecting colorectal cancers. One of its significant advantages is the ability to evaluate both intraluminal and extraluminal regions by combining 3D endoluminal views (virtual colonoscopy) with 2D multiplanar MPR images. This capability allows for precise localization of lesions in relation to extraluminal structures. Additionally, CT colonography provides a bidirectional endoscopic view of the colon, enabling the detection of polyps hidden behind haustral folds, which may be missed during conventional colonoscopy. It also offers several other advantages, including the assessment of bowel wall thickening, evaluation of extracolonic structures and pathologies, and simultaneous screening for recurrence and metastasis in patients who have undergone surgery for colorectal cancer. Moreover, in cases of obstructive carcinoma, CT colonography can assess the proximal colon and detect synchronous tumors, offering a critical diagnostic advantage. This technique is particularly valuable when structural abnormalities, such as colonic obstruction, preclude the complete evaluation of the colon. Identifying proximal lesions can significantly impact surgical planning, as undiagnosed lesions may necessitate additional surgeries or compromise the effectiveness of radical treatment [18]. Fenlon et al., in a study of 34 patients with occlusive distal colon cancer identified via endoscopy, reported additional cancers in the proximal colon in 17 patients. In another study involving 29 patients, CT colonography successfully detected all 29 cases of occlusive cancer, along with 24 polyps and two proximal colon cancers. In our study, no additional cancers were identified. Conventional colonoscopy carries a small but significant risk of serious complications. The perforation rate during screening colonoscopy without polypectomy is approximately 0.056%, increasing to 0.062%–0.082% for colonoscopies overall [19-21]. In one case within our study, massive bleeding occurred as a complication during polypectomy. This underscores the potential of CT colonography as a safer alternative to conventional colonoscopy, particularly for patients at higher risk of complications. In our cohort, complete visualization of the colon was not achieved in 18% of patients using conventional colonoscopy. However, CT colonography successfully provided full colonic imaging in these cases. One of the major advantages of CT colonography is its ability to simultaneously evaluate extracolonic organs within the pelvis and abdomen, offering additional diagnostic value beyond the colon itself.

The primary disadvantages of CT colonography include the necessity for thorough bowel preparation, as residual stool and fluid can obscure colorectal pathology. Another limitation is the occasional insufficient distension of the rectosigmoid region, which can hinder adequate evaluation. Inadequate distension or collapse of colonic segments complicates the interpretation of the images. Additionally, CT colonography may exhibit lower sensitivity for detecting flat polyps, such as sessile serrated adenomas, compared to conventional polypoid lesions.

Limitations of the Study

This study has several noteworthy limitations. The most significant is the relatively small sample size, which may reduce the applicability of the results to a broader population. Moreover, the study did not include any cases of occlusive tumours, limiting the evaluation of CT colonography's performance in such critical conditions. CT colonography also has inherent drawbacks. One concern is the cumulative radiation exposure associated with repeated scans, which poses a potential long-term risk. Additionally, the detection of incidental findings may lead to unnecessary follow-up investigations, increasing healthcare costs and patient anxiety. The technique's utility is further constrained by the limited number of specialized radiologists and imaging facilities capable of offering the procedure.

Another major limitation of CT colonography is its inability to assess mucosal texture and colour changes, which are crucial in identifying certain pathologies. Virtual colononoscopy can be false positives due to artifacts such as pseudopolyps from fecal residue and segmental spasms.

In conclusion, unlike conventional colonoscopy, CT colonography does not allow for biopsy or therapeutic interventions, making the former a superior choice for both diagnostic and treatment purposes when direct mucosal assessment is required. This study demonstrates that CT colonography has a sensitivity of 89% for detecting colorectal polypoid lesions, underscoring its reliability in identifying significant pathologies. As a non-invasive and relatively safe imaging modality, CT colonography offers several advantages over traditional screening methods, including complete colonic visualization and the detection of extracolonic findings. Its high diagnostic accuracy and safety profile make CT colonography a valuable alternative for colorectal cancer screening, particularly in patients who are unable or unwilling to undergo conventional colonoscopy. Furthermore, its ability to detect polyps and early-stage cancers in a selected patient population highlights its potential as a key tool in the early detection and management of colorectal neoplasms.

Ethics Committee Approval

This thesis study was conducted with the permission of the Radiology Department of Social Security Institution Dışkapı Ankara Training Hospital (ethical approval date: 18.07.2022 no: 08)

Conflict of interest statement

The authors declared no conflicts of interest for the authorship and/or publication of this article.

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